LEVELTON CONSULTANTS LTD.

Nanaimo Office
1935 Bollinger Road
Nanaimo, BC V9S 5W9
T: 250.753.1077 F: 250.753.1203
nanaimo@levelton.com
www.levelton.com

12 March 2014
Levelton File # R714-0308-00

WSP Canada Inc.
Suite 400 – 401 Garbally Road
Victoria, BC
V8T 5M3

Attention: Mr. Ron Akehurst, P. Eng.

RE: GEOTECHNICAL ASSESSMENT
HIGHWAY NO. 4 – PACIFIC RIM NATIONAL PARK

1.0 INTRODUCTION

As requested, Levelton Consultants Ltd. (Levelton) has carried out a geotechnical assessment relating to two specific sections of Highway 4 within the Pacific Rim National Park that have been performing poorly. The sections included approximately 300 m of southbound lane near Station 16+000 (as measured from the southern limit of the park) and approximately 50 m of southbound lane near Station 13+000.

Levelton's scope of work was described in our 7 January 2014 proposal (File Reference: P713-3036-00). Authorization to proceed with the work was received from WSP on 3 February 2014.

2.0 SITE REVIEW

The subject sections of road are located on Highway No. 4 near the Esowista Reserve and directly south of the Tofino Airport, as approximately shown on Figure 1. Levelton visited the site on 11 February 2014 to review the site conditions and lay out the locations of boreholes for the subsurface assessment (see below). Select photographs taken during the site visit are attached. A summary of our observations from the site review is presented below.

2.1 Station 16+000

This section of highway was about 300 m in length and had various sections of the east bound lane that appeared to be performing poorly. The worst area appeared at the westernmost part of this section near the Esowista Reserve. This area was a curved and sloped section of road where the terrain sloped down from north to south and from west to east. Concrete barriers ("no-posts") lined the south shoulder of the road and the terrain dropped down steeply to the south to about 6 m in elevation below of the concrete barriers.

Several large longitudinal cracks were observed in this area. The cracks were open at the surface, with the most obvious near the south shoulder where the crack had opened about 60 mm. A tape measurer could reach to a depth of 200 mm before encountering resistance.

The terrain in the easterly part of this section was generally level in an east-west direction along the highway and gently sloped from north down to south across the highway. The slope beyond the south shoulder of road was steep in some areas with an elevation change in the order of 1.5 m to 1.8 m below the road. There was a watercourse with a 1.2 m diameter culvert in this area. Water was present on the inlet (north) and outlet (south) side of the culvert, but flow was only observed entering the inlet side of the culvert.

In 2010, Levelton carried out a subsurface assessment near the eastern part of this section as part of a sewer project. As part of that project, a borehole (BH10-07) was drilled and logged by Levelton about 140 m east of the area on the north side of the road. At that time, the conditions in the borehole consisted of 180 mm of layered asphalt, overlying 580 mm of sand and gravel fill, overlying organic silt. A significant amount of wood debris was encountered at the surface of the organic silt. The approximate location of BH10-07 is shown on Figure 2 and the summary borehole log is attached for reference.

2.2 Station 13+000

The section of highway at Station 13+000 was sloped and curved. The terrain sloped down from the north to south and from the east to west. No-post concrete barriers lined the south side of the road. There was a linear crescent-shaped crack, about 30 to 50 m in length, along the south side of the road. The crack was open at the surface about 12 mm in some areas. Adjacent to the crack, the shoulder of the road was relatively narrow and the terrain dropped down steeply about 10 m in elevation to the south from within about 300 mm from the outside edge of the no-post barriers.

In 2010, Levelton carried out a subsurface assessment near this road section as part of a sewer project. As part of that project, a borehole (BH10-17) was drilled through the south shoulder about 400 m to the west, and a borehole (BH10-20) was drilled through the south shoulder about 250 m to the east. At that time, the conditions in BH10-17 consisted of about 450 mm of sand and gravel fill, overlying natural sand deposits. BH10-20 encountered 450 mm of sand and gravel fill, overlying about 600 mm of silt, overlying silty clay. The approximate locations of BH10-17 and BH10-20 are shown on Figure 3 and their summary logs are attached for reference.

3.0 SUBSURFACE ASSESSMENT

Four boreholes (BH14-01 through BH14-04) were advanced as part of the current assessment at the approximate locations shown on Figures 2 and 3. The boreholes were located in areas where there was visible distress (i.e., cracks) in the east bound lane of the road.

Each borehole was advanced using a track mounted auger drill that was owned and operated by Drillwell Enterprises Ltd. of Duncan, BC. BH14-01, 02, and 03 were advanced within the 300 lineal metre area of road described as 'Station 16+000' in this report. BH14-04 was located within the 50 lineal metre area described as 'Station 13+000'. At each location, the existing asphalt was removed and a Dynamic Cone Penetrometer (DCP) was driven from the point below asphalt to a depth that was greater than the height of the road prism above natural grade to the south. The DCP provides an indication of soil consistency and is recorded as the number of blows per 300 mm depth driven by a 63.5 kg hammer falling 760 mm. Where suspected soft soils were encountered, a field vane was used to measure peak and remolded shear strengths. A solid stem continuous flight auger was advanced at each borehole location to log the subsurface conditions encountered and to recover samples for laboratory testing.

A detailed description of the subsurface conditions encountered is provided on the attached borehole logs. In summary of these logs, a general description is presented as follows:

- Asphalt (in layers 180 mm to 330 mm thick); overlying
- Compact SAND AND GRAVEL (19 mm crush road base) FILL; overlying
- Loose to compact SAND and GRAVEL FILL with some organics; overlying
- Firm to stiff SILTY CLAY.

BH14-02 varied from the above in that loose, organic "midden like" material was encountered at a depth of about 1.5 m to 2.4 m below the sand and gravel fill. Loose sand was found below this material and above the silty clay, which was encountered at a depth of 4.0 m. Groundwater was encountered at a depth of about 1.5 m in this borehole. In addition, geotextile was encountered at a depth of 1.3 m below surface in BH14-04.

3.1 Laboratory Testing

Samples were selected based on the findings for laboratory testing, which included moisture content determination, grain size analysis, and Atterberg Limits testing. The testing results are shown on the borehole logs and the attached sieve analyses sheet, and are summarized in Tables 1 and 2.

Table 1: Summary of Grain Size Analyses

Location	Depth (m)	% Fines*	% Sand	% Gravel
BH14-01	0.3 to 1.2	10.5	77.4	12.1

* Fines include silt and clay size particles.

The above noted grain size analysis is based upon a percentage by mass. Within the 'sand' component, there was a significant amount of wood debris, estimated to be about 50% by volume.

Atterberg Limits were performed on a sample of the fine-grained material from BH14-01, BH14-02, and BH14-04 at a depths of 4.0 m, 4.3 m, and 2.1 m, respectively. The results are presented in the following Table 2:

Table 2: Results of Atterberg Limits

Location	Depth (m)	Plastic Limit %	Liquid Limit %	Plasticity Index	Moisture Content %	Classification
BH14-01	4.0	27.4	81.0	53.6	64.8	CH
BH14-02	4.3	19.1	38.7	19.6	29.7	CM
BH14-04	2.1	44.9	76.4	31.5	68.0	OH

The fine-grained material described in Table 2 is classified as inorganic clays of medium (CM) to high (CH) plasticity and organic clay (OH) - based upon the Canadian Foundation Engineering Manual – 4th Edition.

Outside of moisture content determination, no specific laboratory tests were performed on the midden-like material noted in BH14-02. However, upon drying the sample, a fragment of bone was observed.

4.0 Geotechnical Comments and Recommendations

4.1 General

The results of our field and laboratory testing indicate that the subject road sections are located over compressible soils that are susceptible to long term consolidation settlement under applied loads. It is apparent from the condition of the road sections that settlement is ongoing, especially where there is a relatively steep embankment slope and a relatively narrow shoulder. The potential for larger settlements occur in the highly compressible soils with high moisture content (which were found in BH14-01 and BH14-04), and in areas where organic soils were encountered. In the absence of survey monitoring data, and/or laboratory consolidation data, it is difficult to predict the magnitude of future settlements for these areas. Where organics are encountered, this settlement will continue independently of applied load, as the organics break down over time.

Levelton understands that it was common to use logs to spread the load over these compressible soils during early road construction. During drilling, there was evidence of wood pieces at the interface of fill and underlying natural soils that may be the remains of this type of road construction. There was also an attempt to use geotextile to improve road conditions in the area of BH14-04. Levelton observed the placement of this geotextile material in the 1980's as part of a pavement resurfacing program. The geotextile has not demonstrated to be overly effective in the east bound lane and would not prevent consolidation settlement.

Road repairs in the past have also consisted of placing additional layers of asphalt, which is also evidence that the road has continued to settle over a significant period of time. Placing additional layers of asphalt has added more load to these compressible soil areas.

The midden-like material that was encountered in BH14-02 contained a significant amount of organics and would be prone to settlement. Organic silt deposits found in BH10-07 also contained a significant amount of woody debris. Levelton recommends that the presence of the midden-like material be reported to the Archaeology Branch of the Ministry of Forests, Lands and Natural Resource Operations.

As described above, the 1.2 m diameter culvert that was located near BH14-02 and BH14-03 has flows entering the inlet but not exiting the pipe. As such, it is likely corroded and is allowing water to enter into the road fill prism and subgrade. This condition could lead to future stability issues if the water scours and removes fill and subgrade material during high flows and washes out parts of the road.

4.2 Potential Mitigation Solutions

From a geotechnical perspective, several options could be considered to help mitigate ongoing settlements in the subject sections. With each option, WSP and the Owner should consider long-term performance expectations. One item that should be considered carefully is the performance of the road structure during strong earthquake ground motions. This is particularly important if the section of road in question is the planned evacuation route from a tsunami. Although not included as part of this geotechnical assessment, the loose and wet nature of the sandy soils and the relatively steep embankment fill slopes would likely not perform well in response to strong earthquake ground motions.

The best solution to mitigate settlement would be to avoid the compressible soils and rebuild the road elsewhere. These soils may have been avoided if the road was originally constructed further north. However, assuming that the road alignment will remain in the same location, the most practical solution would include reconstruction of the poorly performing areas, which would include:

1. Removing existing asphalt, fill, organics and wood debris within the road prism;
2. Removing and replacing corroded culverts;
3. Designing a road prism with stable embankment slopes, with grades typically not steeper than 2H:1V; and
4. Constructing a road embankment using lightweight fill products, such as pumice, or expanded polystyrene.

The intent of the lightweight fill would be to create an unloading effect of the highly compressible soils. As noted above, the organic soils and wood debris should be completely removed as they will settle independently of load due to material decomposition.

The design would have to consider a road prism that is wider than the current prism, or include some form of a retaining wall system to stay within the current footprint. A retaining wall system would have to be light enough so as not to add additional load the compressible soils.

If the road footprint is to be widened, the design should account for encountering potential compressible soils that have not experienced any additional loads. A component of the design would include laboratory consolidation testing of these soils to assess how much additional load could be placed on virgin soils and how much would need to be removed from currently loaded soils. Further, more detailed subsurface work would be required to obtain relatively undisturbed Shelby Tube samples of the compressible soils for laboratory consolidation testing. The more detailed geotechnical assessment would also be used to delineate the extent of the compressible deposits and could also be used to establish parameters for a seismic stability assessment, if this was considered important for emergency road evacuation performance.

If the road cannot be reconstructed at this time, some localized improvements could be carried out. These would include repair of existing culverts along with localized unloading which would involve removing layers of existing asphalt and replacing localized poor soils with lightweight backfill. If this is the only option that is considered at this time, light weight pumice fill soils should be incorporated into a geosynthetically confined soil (GCS) system. GSC is a layered network of closely spaced soil (200 mm thick) confined between layers of geotextile. The GCS would provide increased shear strength to support areas that are locally steep and would buffer settlements across the road. This would be best suited for the high embankment and locally steep embankment areas that were encountered at BH14-01 and BH14-04.

Removing and replacing asphalt in these poorly performing areas will be a short lived improvement. Adding more asphalt will potentially worsen the problem.

5.0 FUTURE GEOTECHNICAL SERVICES

For the proposed road upgrade, Levelton anticipates that the following geotechnical services could be required:

- Meet with WSP and the Owner to discuss mitigation options that are in line with expected performance;
- Propose and implement a detailed geotechnical assessment for consolidation work, seismic design, and delineation of poor areas;
- Prepare a design specification and section for lightweight backfill;
- Prepare a retaining wall design;
- Review geotechnical aspects of tender specifications; and
- Carry out construction reviews and provide geotechnical support.

6.0 CLOSURE

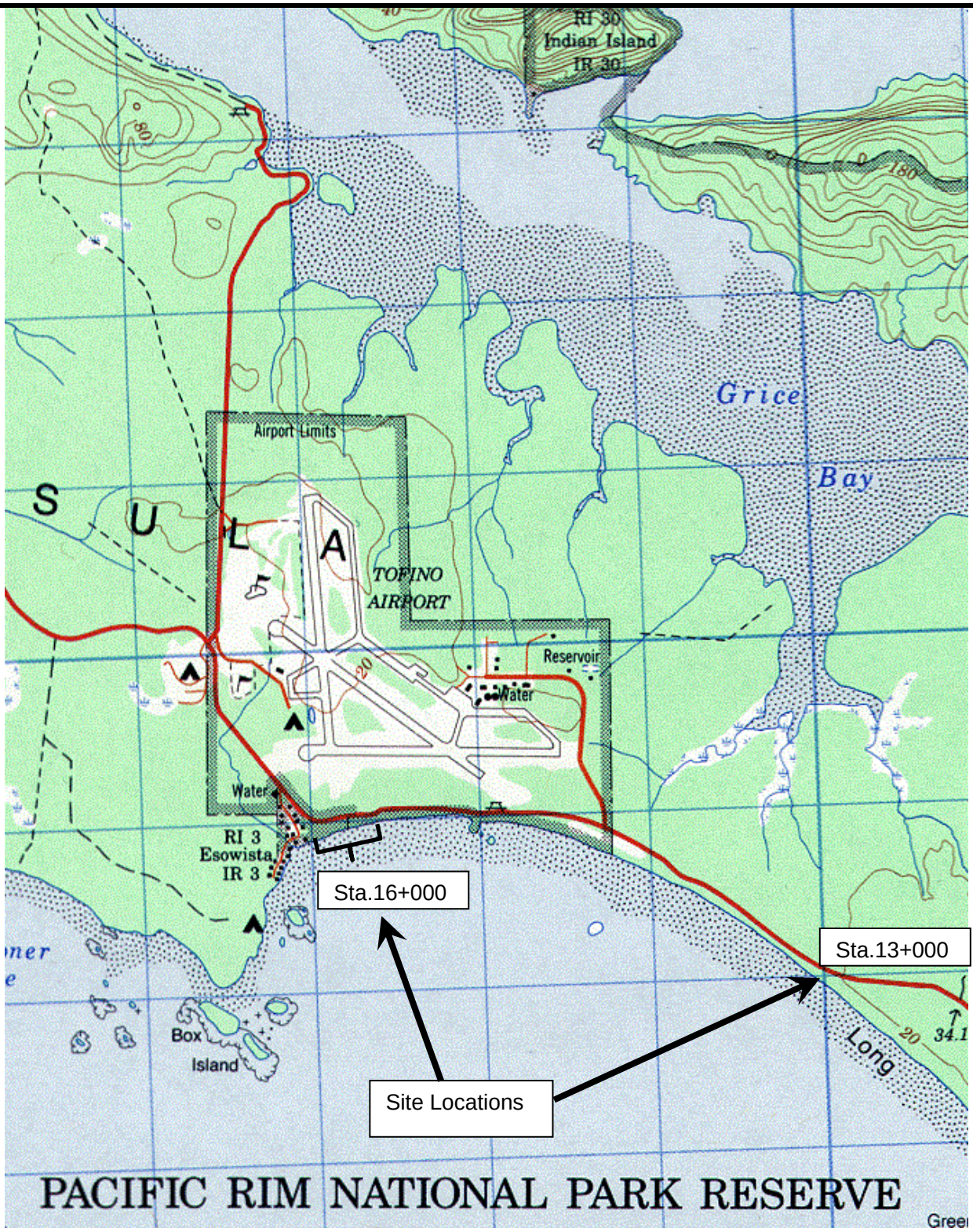
This report has been prepared by Levelton Consultants Ltd. (Levelton) exclusively for WSP Canada Inc. for application to the project described herein. The report has been prepared in accordance with standard soil mechanics practice and the attached Terms of Reference for Geotechnical Reports.

If you have any questions or require further information, please contact the undersigned.

Yours truly,
LEVELTON CONSULTANTS LTD.

	Reviewed by:
SIGNATURE ON FILE	***SIGNATURE ON FILE***
Per: Don Kaluza, P. Eng. Senior Geotechnical Engineer	Tom Oxland, P. Eng. Senior Geotechnical Engineer

Enclosures: Figure 1: Site Location Plan
Figures 2 and 3: Borehole Location Plan
Site Photographs
Borehole Logs
Laboratory Testing
Terms of Reference for Geotechnical Reports



LEVELTON

PROJECT:
Geotechnical Assessment
Highway No. 4 – Pacific Rim National Park

TITLE:
Site Location Plan

CLIENT:
WSP Canada Inc.

FIGURE NO.:	DATE:	FILE NO.:	SCALE:
1	MARCH 2014	R714-0308-00	NTS

Levelton Consultants Ltd., 1935 Bollinger Road, Nanaimo, B.C., V9S 5W9 Phone: 250/753-1077 Fax: 250/753-1203 Email: nanaimo@levelton.com

LEGEND:

- APPROXIMATE BOREHOLE LOCATION LEVELTON 2014
- APPROXIMATE BOREHOLE LOCATION LEVELTON 2010

REV. :	DESCRIPTION:	DATE : (M/D/YR)

PROJECT: GEOTECHNICAL ASSESSMENT
HIGHWAY NO. 4 - PACIFIC RIM NATIONAL PARK, TOFINO, BC

CLIENT: WSP CANADA INC.

TITLE: BOREHOLE LOCATION PLAN - FOR BH14-01, 02, AND 03

THIS DRAWING IS THE SOLE PROPERTY OF LEVELTON CONSULTANTS LTD. AND CANNOT BE USED OR DUPLICATED IN ANY WAY WITHOUT THE EXPRESSED WRITTEN CONSENT OF LEVELTON. THE GENERAL CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND REPORT ANY DISCREPANCIES OR OMMISIONS TO LEVELTON.

DATE: MAR 2014
DESIGN BY: DEK
DRAWN BY: DEK
CHECKED BY: TWO
SCALE: SHOWN

LEVELTON

PROJECT No.: RR14-0308

FIGURE NO.: 2

LEGEND:

- APPROXIMATE BOREHOLE LOCATION LEVELTON 2014
- APPROXIMATE BOREHOLE LOCATION LEVELTON 2010

REV. :	DESCRIPTION:	DATE : (M/D/YR)

PROJECT: GEOTECHNICAL ASSESSMENT
HIGHWAY NO 4 - PACIFIC RIM NATIONAL PARK, TOFINO, BC

CLIENT: WSP CANADA INC.

TITLE: BOREHOLE LOCATION PLAN - BH14-04

DATE: MAR 2014
DESIGN BY: DEK
DRAWN BY: DEK
CHECKED BY: TWO
SCALE: SHOWN

LEVELTON

THIS DRAWING IS THE SOLE PROPERTY OF LEVELTON CONSULTANTS LTD. AND CANNOT BE USED OR DUPLICATED IN ANY WAY WITHOUT THE EXPRESSED WRITTEN CONSENT OF LEVELTON. THE GENERAL CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND REPORT ANY DISCREPANCIES OR OMMISIONS TO LEVELTON.

PROJECT No.: R714-0308

FIGURE NO.: 3

Photo 1: Condition of road on eastbound lane near Esowista IR #3 (11 February 2014)

Photo 2: Open crack in south shoulder of road near BH14-01 (11 February 2014)

LEVELTON	PROJECT: Geotechnical Assessment Highway No. 4 – Pacific Rim National Park	
	TITLE: Site Photographs	
	CLIENT: WSP Canada Inc.	
PHOTO NOS.: 1 and 2	DATE: MARCH 2014	FILE NO.: R714-0308-00

Levelton Consultants Ltd., 1935 Bollinger Road, Nanaimo, B.C., V9S 5W9 Phone: 250/753-1077 Fax: 250/753-1203 Email: nanaimo@levelton.com

Photo 3: Road embankment slope south of BH14-01 (11 February 2014)

Photo 4: View looking east of open crack in road near BH14-02 and BH14-03 (11 February 2014)

LEVELTON	PROJECT: Geotechnical Assessment Highway No. 4 – Pacific Rim National Park	
	TITLE: Site Photographs	
	CLIENT: WSP Canada Inc.	
PHOTO NOS.: 3 and 4	DATE: MARCH 2014	FILE NO.: R714-0308-00

Levelton Consultants Ltd., 1935 Bollinger Road, Nanaimo, B.C., V9S 5W9 Phone: 250/753-1077 Fax: 250/753-1203 Email: nanaimo@levelton.com

Photo 5: Road embankment slope south of BH14-01 (11 February 2014)

Photo 6: View looking east of open crack in road near BH14-02 and BH14-03 (11 February 2014)

LEVELTON	PROJECT: Geotechnical Assessment Highway No. 4 – Pacific Rim National Park	
	TITLE: Site Photographs	
	CLIENT: WSP Canada Inc.	
PHOTO NOS.: 5 and 6	DATE: MARCH 2014	FILE NO.: R714-0308-00

Levelton Consultants Ltd., 1935 Bollinger Road, Nanaimo, B.C., V9S 5W9 Phone: 250/753-1077 Fax: 250/753-1203 Email: nanaimo@levelton.com

Photo 7: View looking west at road condition near BH14-04 (11 February 2014)

Photo 8: View looking east at road condition near BH14-04 (11 February 2014)

LEVELTON	PROJECT: Geotechnical Assessment Highway No. 4 – Pacific Rim National Park	
	TITLE: Site Photographs	
	CLIENT: WSP Canada Inc.	
PHOTO NOS.: 7 and 8	DATE: MARCH 2014	FILE NO.: R714-0308-00

LEVELTON

Geotechnical Assessment
Highway 4 - Pacific Rim National Park
WSP Canada Inc.

BH14-01

Project No: R714-0308-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT (330mm), ≥ 5 layers.				
		Compact, dark grey, **SAND AND GRAVEL (FILL),** 19mm, crushed, base course.				
		Loose, black and brown, **SAND AND GRAVEL,** organic, moist to wet with depth.			G	
2	5					
		Firm, orange brown, silty, **CLAY,** trace to some sand lenses.			G	
	10	- firm, blue grey, wet				
4					G	
	15	- stiff.				
					G	
6	20					
					G	
	25					
8					G	
	30	Bottom of hole at 9.1 metres				
10						
	35					
12						
	40					
	45					

10 20 30 40 50 60 70 80 90

- Hand excavated

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Solid Stem Auger / DCPT
Date Drilled: 23/01/2014
By: RH

THIS LOG IS FOR GEOTECHNICAL PURPOSES ONLY
THIS LOG IS THE SOLE PROPERTY OF LEVELTON CONSULTANTS LTD AND CANNOT BE USED OR DUPLICATED IN ANY WAY WITHOUT EXPRESS WRITTEN PERMISSION.

1 LOG PER PAGE R714-0308-00.GPJ LEVELTON.GDT 12/3/14

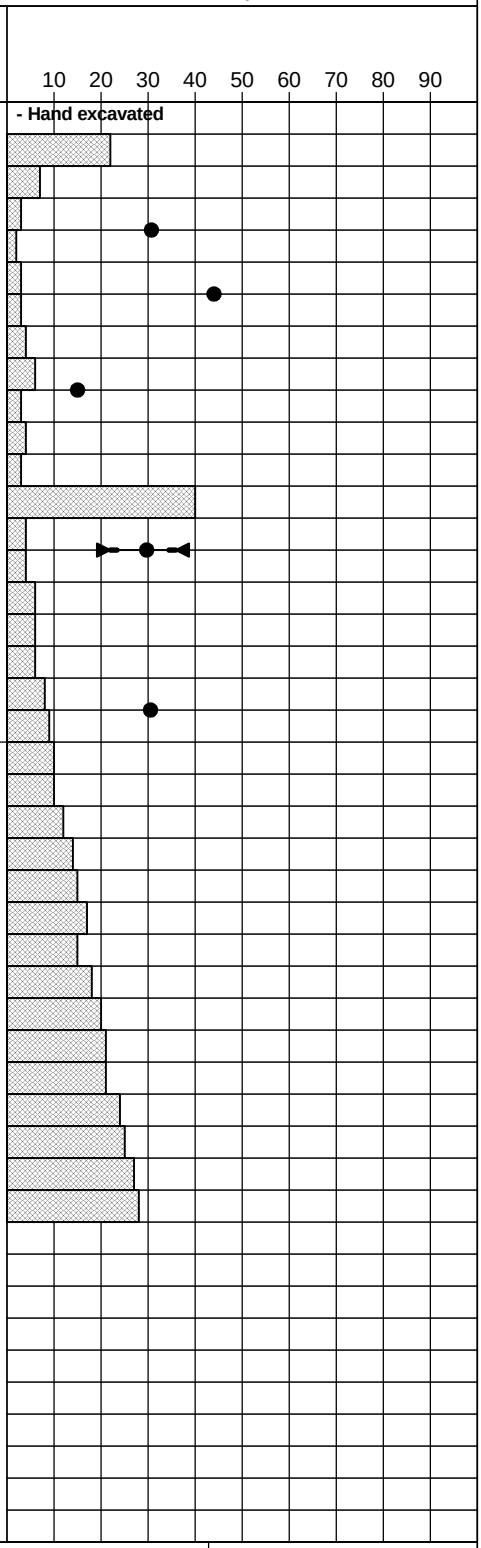
LEVELTON

Geotechnical Assessment
Highway 4 - Pacific Rim National Park
WSP Canada Inc.

BH14-02

Project No: R714-0308-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT (180mm), ≥ 4 layers.				
		Compact, dark grey, **SAND AND GRAVEL (FILL),** crushed, 19mm.				
		Compact, grey, **SAND AND GRAVEL (FILL),** pit run, moist.			G	
	5	Loose, black, **SAND AND GRAVEL,** organic, wet.			G	
2		Loose, black, **SAND AND GRAVEL,** midden-like, organic, wet.			G	
	10	Loose, black, **SAND,** some gravel, wet.			G	
4		- layer of gravel/cobble at 3.7 to 4.0m.				
	15	Firm, grey, silty, **CLAY,** trace sand and gravel, moist.			G	
6	20	Bottom of hole at 6.1 metres				
8	25					
	30					
10	35					
12	40					
	45					



C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger / DCPT
Date Drilled: 23/01/2014
By: RH

THIS LOG IS FOR GEOTECHNICAL PURPOSES ONLY
THIS LOG IS THE SOLE PROPERTY OF LEVELTON CONSULTANTS LTD AND CANNOT BE USED OR DUPLICATED IN ANY WAY WITHOUT EXPRESS WRITTEN PERMISSION.

1 LOG PER PAGE R714-0308-00.GPJ LEVELTON.GDT 12/3/14

LEVELTON

Geotechnical Assessment
Highway 4 - Pacific Rim National Park
WSP Canada Inc.

BH14-03

Project No: R714-0308-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
				Dynamic Cone Pentration Test		

10 20 30 40 50 60 70 80 90

BH14-03 next to BH14-02
- likely gravel layering from 3.0 to 4.3m

2 4 6 8 10 12

5 10 15 20 25 30 35 40 45

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: DCPT
Date Drilled: 23/01/2014
By: RH

THIS LOG IS FOR GEOTECHNICAL PURPOSES ONLY
THIS LOG IS THE SOLE PROPERTY OF LEVELTON CONSULTANTS LTD AND CANNOT BE USED OR DUPLICATED IN ANY WAY WITHOUT EXPRESS WRITTEN PERMISSION.

LEVELTON

Geotechnical Assessment
Highway 4 - Pacific Rim National Park
WSP Canada Inc.

BH14-04

Project No: R714-0308-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT (180mm), ≥ 3 layers.			G	
		Compact, dark grey, **SAND AND GRAVEL (FILL),** crushed, 19mm.			G	
		Compact, brown, **SAND AND GRAVEL (FILL),** pit run, moist. - filter cloth (grey and white) observed at 1.3m.				
2	5	Firm to stiff, grey, silty, **CLAY,** some wood debris sizes to 25mm diameter, some organic, moist. - trace shells observed at 1.6m depth			G	
	10	- blue grey, trace sand and gravel, moist				
4					G	
	15	- yellow brown, trace gravel, moist				
		- blue grey, occasional gravel sizes to 25mm diameter.				
6	20				G	
	25				G	
8		Bottom of hole at 7.6 metres				
	30					
10						
	35					
12	40					
	45					

10 20 30 40 50 60 70 80 90

- Hand excavated

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger / DCPT
Date Drilled: 23/01/2014
By: RH

THIS LOG IS FOR GEOTECHNICAL PURPOSES ONLY
THIS LOG IS THE SOLE PROPERTY OF LEVELTON CONSULTANTS LTD AND CANNOT BE USED OR DUPLICATED IN ANY WAY WITHOUT EXPRESS WRITTEN PERMISSION.

Levelton Consultants Ltd.

8-2663 Kilpatrick Avenue
Courtenay, BC
Canada V9N 7C8
Tel.: 250-334-9222
Fax.: 250-334 3955
E-mail: courtenay@levelton.com

AGGREGATE GRADATION ANALYSIS

IDENTIFICATION:

Client: Genivar
Project: Highway 4, Slope Review - Pacific Rim National Park, BC
Sample Location: BH14-01 @ 0.3 to 1.2m depth

File No: R714-0308-00
Report No.: 1
Date: 27-Feb-14

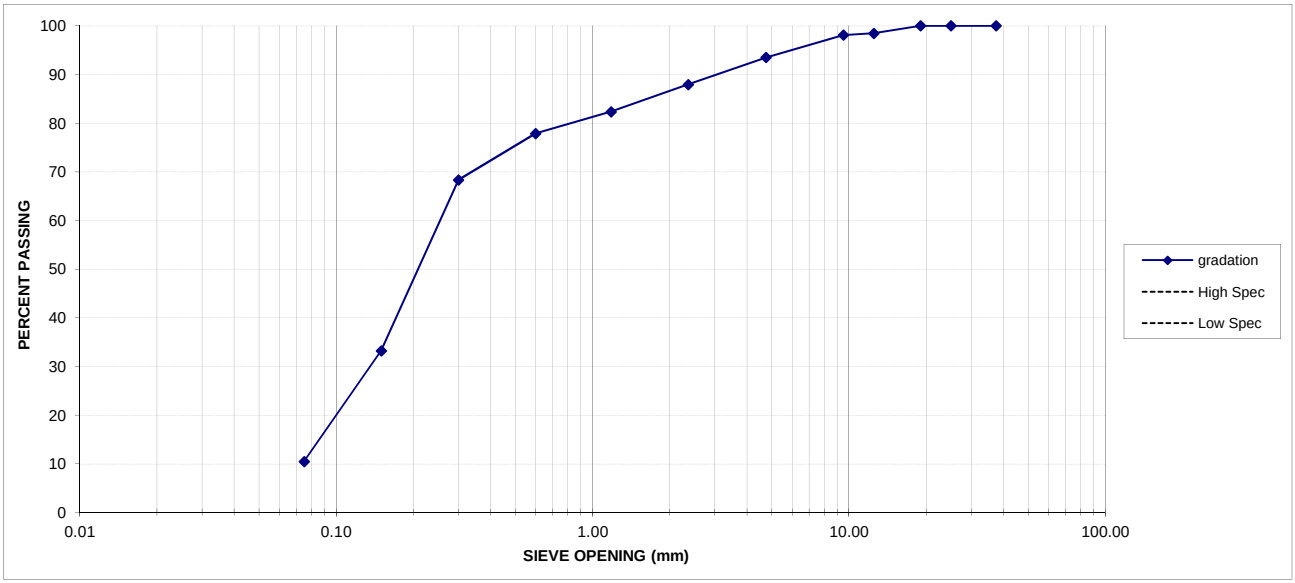
SAMPLING INFORMATION:

Material: Organic Sand, fine to medium grained, trace gravel, some silt
Specification: Gradation

Date Sampled	21-Feb-14
Date Tested	27-Feb-14
Sample No.:	1
Fracture:	na
Supplier:	LCL
Sampled by:	RH
Tested by:	RH

Material Specification			Sieve Analysis	
Sieve	High Spec	Low Spec	Sieve	% Passing
			37.5	100.0
			25	100.0
			19	100.0
			12.5	98.5
			9.50	98.1
			4.75	93.5
			2.36	87.9
			1.18	82.4
			0.600	77.9
			0.300	68.4
			0.150	33.3
			0.075	10.5

AGGREGATE GRADATION:



REMARKS: Tested in accordance with ASTM C- 136 and C-117
Wood Debris observed to be approximately 50%
by volume retained on the 2.36mm sieve.

REPORTS TO:

LEVELTON CONSULTANTS LTD.

per:

This report represents a testing service only. No engineering interpretation opinion is expressed or implied. Engineering review and interpretation can be provided on written request.

LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-07

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT				
		Compact, grey, **SAND AND GRAVEL (FILL),** occasional cobble.				
	2	Loose, **VARIOUS FILL,** some sand and gravel, some silt, moist.				
		ORGANIC SILT, moist. - lots of wood debris observed				
	4				G	
		- some gravel observed below 1.5m - wet below 1.5m depth.				
2	6					
	8				G	
	10	Bottom of hole at 3.1 metres				
	12					
4	14					
	16					
	18					
6	20					
	22					
	24					

10 20 30 40 50 60 70 80 90

- Advancement of 0.15m x 100 Blows

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger / DCPT
Date Drilled: 7/23/2010
By: RH

THIS LOG IS FOR GEOTECHNICAL PURPOSES ONLY
THIS LOG IS THE SOLE PROPERTY OF LEVELTON CONSULTANTS LTD AND CANNOT BE USED OR DUPLICATED IN ANY WAY WITHOUT EXPRESS WRITTEN PERMISSION.

LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-17

Pg 1 of 1

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Compact, **SAND AND GRAVEL (FILL),** road base to subbase, moist.				
	2	Dense, grey, **SAND,** medium to fine grained, trace to some gravel, moist.			G	
	4					
	6					
2		- wet below 2.0m - gravel content increases with depth.				
	8					
	10				G	
		Bottom of hole at 3.1 metres				
	12					
4						
	14					
	16					
	18					
6						
	20					
	22					
	24					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 In. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger
Date Drilled: 7/22/2010
By: RH

THIS LOG IS FOR GEOTECHNICAL PURPOSES ONLY
THIS LOG IS THE SOLE PROPERTY OF LEVELTON CONSULTANTS LTD AND CANNOT BE USED OR DUPLICATED IN ANY WAY WITHOUT EXPRESS WRITTEN PERMISSION.

LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-20
Pg 1 of 1

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Compact, **SAND AND GRAVEL (VARIOUS FILL),** road base and subbase, trace to some silt, moist.				
	2	Soft to firm, mottled orange brown, **SILT,** trace gravel, moist.				
	4	Firm, orange brown, silty, **CLAY,** trace sand and gravel.				
	6				G	
2						
	8	- firm, blue grey, trace to some gravel, moist at 2.5m			G	
	10	- increased plasticity content below 3.0m - trace to some sand below 3.0m depth.				
	12				G	
		Bottom of hole at 3.7 metres				
4						
	14					
	16					
	18					
6						
	20					
	22					
	24					

10 20 30 40 50 60 70 80 90

FP @ 1.5m = 1.5 tsf

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger / DCPT
Date Drilled: 7/22/2010
By: RH

THIS LOG IS FOR GEOTECHNICAL PURPOSES ONLY
THIS LOG IS THE SOLE PROPERTY OF LEVELTON CONSULTANTS LTD AND CANNOT BE USED OR DUPLICATED IN ANY WAY WITHOUT EXPRESS WRITTEN PERMISSION.

1 LOG PER PAGE VI10-1223-00.GPJ LEVELTON.GDT 8/19/10

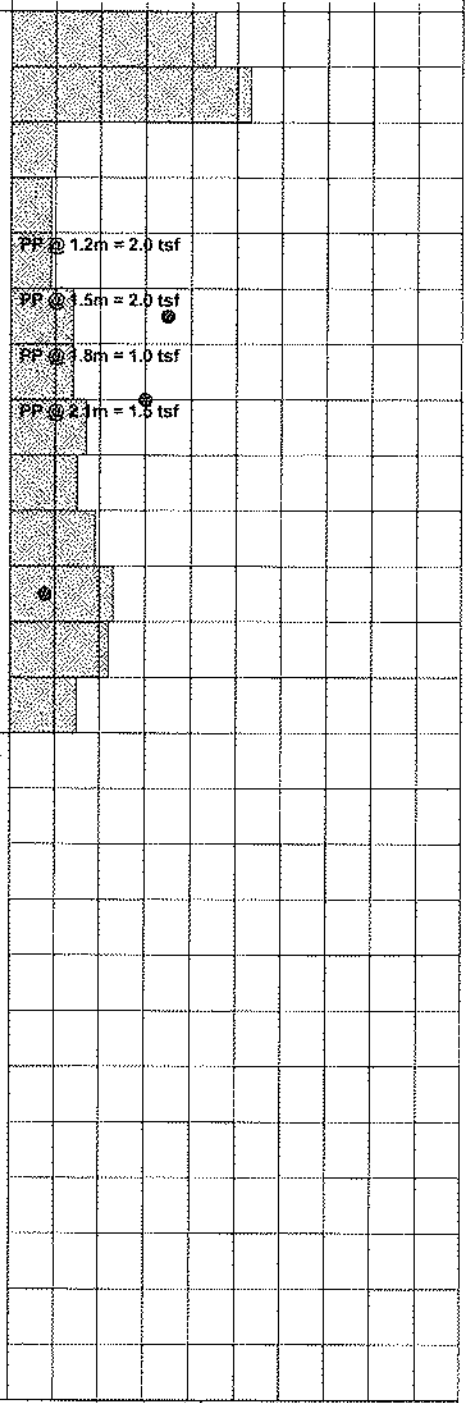
LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-21
Pg 1 of 1

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Compact to dense, brown, **SAND AND GRAVEL (FILL)**, roadbase/subbase, occasional cobble sizes to 100mm diameter.				
	2	Firm to stiff, mottled orange brown/grey, **SILT**, trace sand, occasional gravel sizes to 50mm diameter, moist.				
	4					
	6				G	
2		-stiff, greenish/blue, trace to some sand, moist.			G	
	8					
	10	Compact to dense, blue grey, silty, **SAND AND GRAVEL**, numerous gravel sizes to 25mm diameter, wet.			G	
	12					
4		Bottom of hole at 4.0 metres				
	14					
	16					
	18					
6	20					
	22					
	24					



C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger / DCPT
Date Drilled: 7/22/2010
By: RH

THIS LOG IS FOR GEOTECHNICAL PURPOSES ONLY
THIS LOG IS THE SOLE PROPERTY OF LEVELTON CONSULTANTS LTD AND CANNOT BE USED OR DUPLICATED IN ANY WAY WITHOUT EXPRESS WRITTEN PERMISSION.

1 LOG PER PAGE VI10-1223-00.GPJ LEVELTON.GDT 8/19/10

TERMS OF REFERENCE FOR GEOTECHNICAL REPORTS ISSUED BY LEVELTON CONSULTANTS LTD.

1. STANDARD OF CARE

Levelton Consultants Ltd. ("Levelton") prepared and issued this geotechnical report (the "Report") for its client (the "Client") in accordance with generally-accepted engineering consulting practices for the geotechnical discipline. No other warranty, expressed or implied, is made. Unless specifically stated in the Report, the Report does not address environmental issues.

The terms of reference for geotechnical reports issued by Levelton (the "Terms of Reference") contained in the present document provide additional information and caution related to standard of care and the use of the Report. The Client should read and familiarize itself with these Terms of Reference.

2. COMPLETENESS OF THE REPORT

All documents, records, drawings, correspondence, data, files and deliverables, whether hard copy, electronic or otherwise, generated as part of the services for the Client are inherent components of the Report and, collectively, form the instruments of professional services (the "Instruments of Professional Services"). The Report is of a summary nature and is not intended to stand alone without reference to the instructions given to Levelton by the Client, the communications between Levelton and the Client, and to any other reports, writings, proposals or documents prepared by Levelton for the Client relative to the specific site described in the Report, all of which constitute the Report.

TO PROPERLY UNDERSTAND THE INFORMATION, OBSERVATIONS, FINDINGS, SUGGESTIONS, RECOMMENDATIONS AND OPINIONS CONTAINED IN THE REPORT, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. LEVELTON CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT AND ITS VARIOUS COMPONENTS.

3. BASIS OF THE REPORT

Levelton prepared the Report for the Client for the specific site, development, building, design or building assessment objectives and purpose that the Client described to Levelton. The applicability and reliability of any of the information, observations, findings, suggestions, recommendations and opinions contained in the Report are only valid to the extent that there was no material alteration to or variation from any of the said descriptions provided by the Client to Levelton unless the Client specifically requested Levelton to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information, observations, findings, suggestions, recommendations and opinions contained in the Report, or any component forming the Report, are for the sole use and benefit of the Client and the team of consultants selected by the Client for the specific project that the Report was provided. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION OR COMPONENT WITHOUT THE WRITTEN CONSENT OF LEVELTON. Levelton will consent to any reasonable request by the Client to approve the use of this Report by other parties designated by the Client as the "Approved Users". As a condition for the consent of Levelton to approve the use of the Report by an Approved User, the Client must provide a copy of these Terms of Reference to that Approved User and the Client must obtain written confirmation from that Approved User that the Approved User will comply with these Terms of Reference, such written confirmation to be provided separately by each Approved User prior to beginning use of the Report. The Client will provide Levelton with a copy of the written confirmation from an Approved User when it becomes available to the Client, and in any case, within two weeks of the Client receiving such written confirmation.

The Report and all its components remain the copyright property of Levelton and Levelton authorises only the Client and the Approved Users to make copies of the Report, but only in such quantities as are reasonably necessary for the use of the Report by the Client and the Approved Users. The Client and the Approved Users may not give, lend, sell or otherwise disseminate or make the Report, or any portion thereof, available to any party without the written permission of Levelton. Any use which a third party makes of the Report, or any portion of the Report, is the sole responsibility of such third parties. Levelton accepts no responsibility for damages suffered by any third party resulting from the use of the Report. The Client and the Approved Users acknowledge and agree to indemnify and hold harmless Levelton, its officers, directors, employees, agents, representatives or sub-consultants, or any or all of them, against any claim of any nature whatsoever brought against Levelton by any third parties, whether in contract or in tort, arising or related to the use of contents of the Report.

5. INTERPRETATION OF THE REPORT

a. **Nature and Exactness of Descriptions**: The classification and identification of soils, rocks and geological units, as well as engineering assessments and estimates have been based on investigations performed in accordance with the standards set out in Paragraph 1 above. The classification and identification of these items are judgmental in nature and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations or assessments utilizing the standards of Paragraph 1 involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk. Some conditions are subject to changes over time and the parties making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or when the Client has special considerations or requirements, the Client must disclose them to Levelton so that additional or special investigations may be undertaken, which would not otherwise be within the scope of investigations made by Levelton or the purposes of the Report.

b. **Reliance on information**: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site investigation and field review and on the basis of information provided to Levelton. Levelton has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Levelton cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the report as a result of misstatements, omissions, misrepresentations or fraudulent acts of persons providing information.

c. **Additional Involvement by Levelton**: To avoid misunderstandings, Levelton should be retained to assist other professionals to explain relevant engineering findings and to review the geotechnical aspects of the plans, drawings and specifications of other professionals relative to the engineering issues pertaining to the geotechnical consulting services provided by Levelton. To ensure compliance and consistency with the applicable building codes, legislation, regulations, guidelines and generally-accepted practices, Levelton should also be retained to provide field review services during the performance of any related work. Where applicable, it is understood that such field review services must meet or exceed the minimum necessary requirements to ascertain that the work being carried out is in general conformity with the recommendations made by Levelton. Any reduction from the level of services recommended by Levelton will result in Levelton providing qualified opinions regarding adequacy of the work.

6. ALTERNATE REPORT FORMAT

When Levelton submits both electronic and hard copy versions of the Instruments of Professional Services, the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding upon Levelton. The hard copy versions submitted by Levelton shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancy, the hard copy versions shall govern over the electronic versions; furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed and sealed versions of the Instruments of Professional Services maintained or retained, or both, by Levelton shall be deemed to be the overall originals for the Project.

The Client agrees that the electronic file and hard copy versions of Instruments of Professional Services shall not, under any circumstances, no matter who owns or uses them, be altered by any party except Levelton. The Client warrants that the Instruments of Professional Services will be used only and exactly as submitted by Levelton.

The Client recognizes and agrees that Levelton prepared and submitted electronic files using specific software or hardware systems, or both. Levelton makes no representation about the compatibility of these files with the current or future software and hardware systems of the Client, the Approved Users or any other party. The Client further agrees that Levelton is under no obligation, unless otherwise expressly specified, to provide the Client, the Approved Users and any other party, or any or all of them, with specific software and hardware systems that are compatible with any electronic submitted by Levelton. The Client further agrees that should the Client, an Approved User or a third party require Levelton to provide specific software or hardware systems, or both, compatible with the electronic files prepared and submitted by Levelton, for any reason whatsoever included but not restricted to an order from a court, then the Client will pay Levelton for all reasonable costs related to the provision of the specific software or hardware systems, or both. The Client further agrees to indemnify and hold harmless Levelton, its officers, directors, employees, agents, representative or sub-consultant, or any or all of them, against any claim or any nature whatsoever brought against Levelton, whether in contract or in tort, arising or related to the provision or use or any specific software or hardware provided by Levelton.